8.2 Ecosystem Monitoring and Ecological Compliance

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The Hanford Site is a relatively undisturbed area of shrub-steppe that contains a rich, natural diversity of plant and animal species adapted to the region's semiarid environment. In a summary document based on 5 years of intense study, The Nature Conservancy of Washington (1999) reported that "The Hanford Site Biodiversity Inventory has produced remarkable findings in each of the biological subject areas that were addressed: plant communities, rare plants, noxious weeds, small mammals, insects (aquatic and terrestrial), amphibians and reptiles, and soil mosses and lichens (the microbiotic crust)." In 2000, the biodiversity of Hanford was further recognized as a national asset when portions of the site were designated as the Hanford Reach National Monument (65 FR 114). Ecosystem monitoring and ecological compliance have multiple objectives that support completion of Hanford's waste management and environmental restoration mission within this high quality and valued natural ecosystem. These objectives include:

- ensuring Hanford Site operational compliance with laws and regulations including the *Migratory Bird Treaty Act*, the *Bald and Golden Eagle Protection Act*, and the *Endangered Species Act*
- providing data for environmental impact and ecological risk assessments
- providing maps and information useful for biological resource impact mitigation during facilities expansion
- supporting Hanford Site land-use planning
- supporting natural resource protection within the DOE operated portions of the Hanford Site including the DOE managed portion of the Hanford Reach National Monument
- providing information useful to the tribes, Hanford natural resource stakeholders, and the public on the status of some of Hanford's most highly valued biological resources.

8.2.1 Chinook Salmon

Chinook salmon are an important resource in the Pacific Northwest; they are caught commercially and for recreation. Salmon are also of cultural importance to Native American tribes. Today, the most important natural spawning area in the mainstem Columbia River for the fall chinook salmon is found in the free-flowing Hanford Reach. In the early years of the Hanford Site, there were few spawning nests (redds) in the Hanford Reach (Figure 8.2.1). Between 1943 and 1971, a number of dams were constructed on the Columbia River. Their reservoirs eliminated most mainstem spawning areas, resulting in increased numbers of salmon spawning in the Hanford Reach. Fisheries management strategies aimed at maintaining spawning populations in the mainstem Columbia River also have contributed to the increases.

The number of fall chinook salmon redds counted in the Hanford Reach by aerial surveys

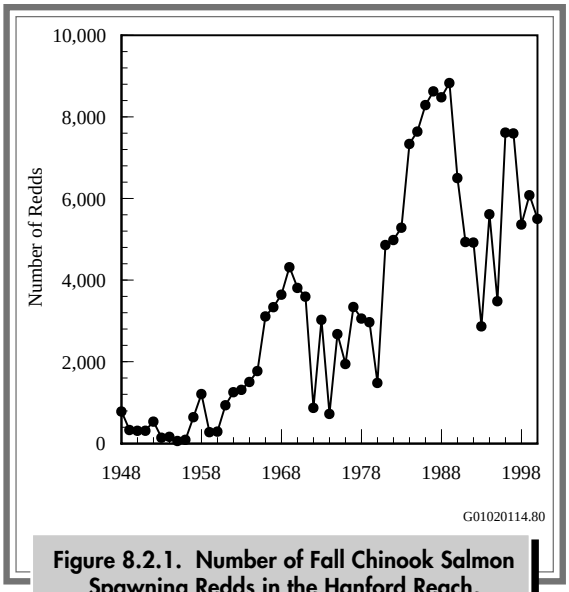

Figure 8.2.1. Number of Fall Chinook Salmon Spawning Redds in the Hanford Reach, 1948 through 2000

increased during the 1960s, 1970s, and 1980s until reaching a high in 1989 of nearly 9,000 (see Figure 8.2.1). In the early 1990s, redd counts declined to approximately one-third of the 1989 peak. The number of redds peaked again in 1996 and 1997 and has once again declined. In 2000, ~5,507 redds were observed, a decrease of 580 from 1999 and ~70% of the 1996 and 1997 totals. The main use areas were similar to previous years with the majority of redds occurring near Locke Island, the Columbia River islands between river miles 365–368 (Islands 8 through 10), and Vernita Bar. It should be noted that aerial surveys do not yield absolute redd counts because visibility varies, depending on water depth and other factors, and because the number of redds in high-density locations cannot be counted accurately. However, redd survey data generally agree with adult numbers obtained by counting migrating adult fish at fish ladders on the Columbia River. The Hanford Reach remains the most important spawning area for fall chinook salmon in the mainstem Columbia River.

8.2.2 Bald Eagle

The bald eagle is listed as a federally threatened species (50 CFR 17.11) and also as a Washington State threatened species (Washington State Department of Wildlife 1994); however, the bald eagle is currently under review for removal from the federal endangered species list. Protection for bald eagles on the Hanford Site is guided by the management plan contained in DOE/RL-94-150 and coordinated with representatives of the U.S. Fish and Wildlife Service.

Historically, bald eagles have wintered along the Hanford Reach of the Columbia River. The wintering eagles originate from various places, including interior Alaska, British Columbia, Northwest Territories, Saskatchewan, and possibly Manitoba. However, when monitoring began in the early 1960s, numbers were low (Figure 8.2.2). Following passage of the *Endangered Species Act* (Appendix G, Table G.1), the number of wintering bald eagles generally has

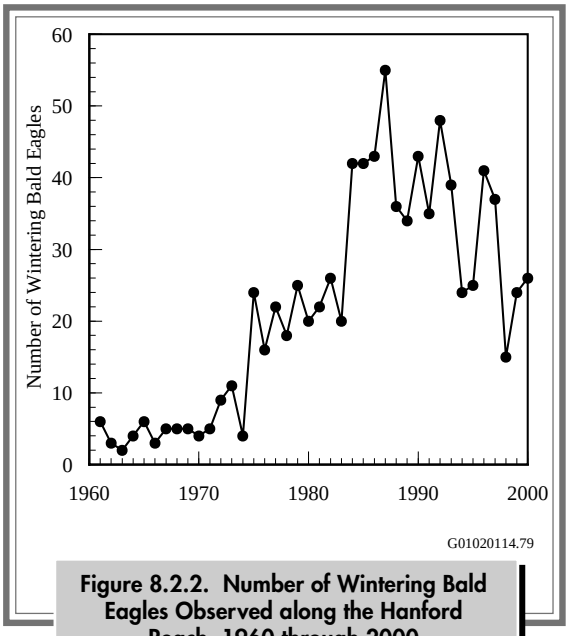

Figure 8.2.2. Number of Wintering Bald Eagles Observed along the Hanford Reach, 1960 through 2000

increased. Primary reasons for this increase are 1) reduced persecution in Alaska, 2) protection of bald eagles at nesting locations, and 3) nationwide elimination of dichlorodiphenyltrichloroethane (DDT) as an agricultural pesticide in 1972.

The number of nesting eagles was estimated at ~25,000 in the lower 48 states when the bird was adopted as our national symbol in 1782. From fewer than 450 nesting pairs in the early 1960s, there are now more than 4,000 nesting pairs in the lower 48 states. When eagles were federally listed as endangered, recovery goals included at least 800 nesting pairs collectively in California, Idaho, Montana, Oregon, Utah, and Washington (i.e., the Pacific states). In 1997, wildlife experts estimated more than 1,200 nesting pairs in the Pacific states region. Only two pairs of nesting eagles are known to occur in southeastern Washington.

A maximum count of 26 eagles (11 adults and 15 juveniles) was observed along the Hanford Reach in 2000. Five surveys were successfully completed between December 1, 2000 and January 26, 2001. This maximum count is similar to those seen in the late 1970s and early 1980s and indicates that the low count in 1998 was likely a reflection of changes in food availability near the birds nesting territories and hence winter migration patterns.

Changes in the number of eagles on the Hanford Site generally have corresponded to changes in the number of returning fall chinook salmon, a major fall and winter food source for eagles (compare Figures 8.2.1 and 8.2.2 to see similarity in the patterns of salmon redd counts and bald eagle counts). In 2000, one eagle pair defended an historic nest site through mid-March. This nesting attempt by an eagle pair, one of which was just reaching adulthood, suggests the birds were born and raised near this area. A nest site protection buffer of 0.8 kilometer (0.5 mile) around the nest was initiated for all Hanford activities in December 2000.

8.2.3 Hawks

The undeveloped land of the semiarid areas of the Hanford Site provides nest sites and food for three species of migratory buteo hawks: Swainson's, red-tailed, and ferruginous. Under natural conditions, these hawks nest in trees, on cliffs, or on the ground. Power-line towers and poles also can serve as nest sites. These structures are used extensively by nesting hawks on the site because of the relative scarcity of trees and cliffs. The ferruginous hawk is a Washington State threatened species (Washington State Department of Wildlife 1994) as well as a U.S. Fish and Wildlife Service species of concern for eastern Washington (50 CFR 17.11). Approximately one quarter of the state's ferruginous hawk nesting territories are located on the site.

Since 1995, the number of ferruginous hawks nesting on the Hanford Site has ranged from 7 to 12. There were eight active ferruginous hawk nests in 2000, the same number as in 1999. Additionally, an osprey (*Pandion haliaetus*) nest was seen in 2000 and was the first recorded nesting on the Hanford Site. The site continues to provide hawk-nesting habitats that are administratively protected from public intrusion. An evaluation of selected aspects of ferruginous hawk ecology on the site and adjacent lands was completed in 1996 (Leary 1996). That work suggested that ferruginous hawks nest on the site because of suitable, disturbance-free habitat, and the proximity of agricultural fields available for foraging.

Ten ferruginous hawks nesting in south central Washington State were captured in 1999 and tagged with satellite telemetry transmitters. In 2000, two more birds were captured and tagged. The transmitters send signals to satellites that relay location information back to ground stations. From there, biologists retrieve the information daily via computer, within 2 to 6 hours of signal reception, to track

the hawk's movements. The 2-year study lead by the Washington State Department of Fish and Wildlife, in cooperation with Pacific Northwest National Laboratory, was initiated in 2000 to learn more about the bird's migration patterns and help recover their declining populations nationwide.

8.2.4 Rocky Mountain Elk

Rocky Mountain elk did not inhabit the Hanford Site when it was established in 1943. Elk were first observed on the Fitzner/Eberhardt Arid Lands Ecology Reserve in the winter of 1972. A few animals stayed and reproduced. The Rattlesnake Hills elk herd now occupies portions of the Hanford Site, the United States Army's Yakima Training Center, and private land along Rattlesnake Ridge. Herd size was estimated from census data at 747 animals at the end of the 1999 hunting season (Figure 8.2.3). A roundup conducted by the U.S. Fish and Wildlife Service and Washington State Department of Fish and Wildlife in mid-March 2000 resulted in the removal of 171 animals. Pacific Northwest National Laboratory estimated 32 calves (±2 calves standard error) per 100 cows were recruited into the population, bringing the total count to 660 animals in fall 2000. The 2000 minimum estimated harvest was ~207 animals, and census data after the hunting seasons found ~440 animals remaining in the Rattlesnake Hills.[a] The larger number of elk harvested in 2000 (~30% of the population) may be related to the hunting strategy developed in 1999, that established three separate hunting seasons prior to the opening of the season. In addition, the June wildfire (see Section 5.0) resulted in more elk using private range and crop lands adjacent to the Hanford Site during the hunting season.

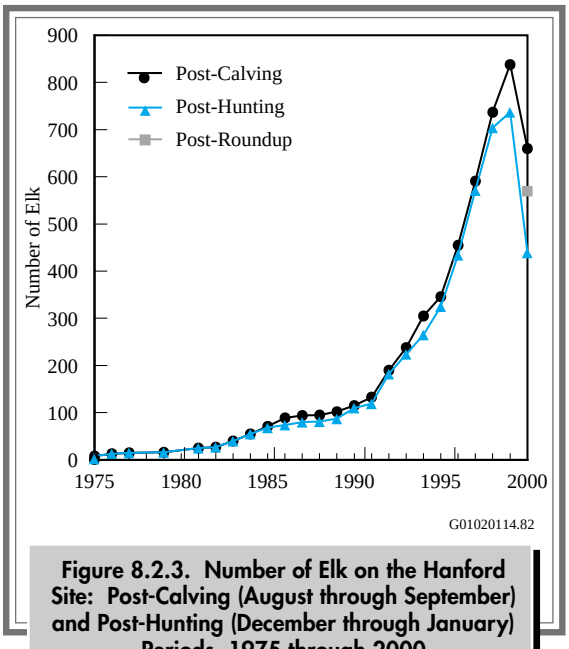

Figure 8.2.3. Number of Elk on the Hanford Site: Post-Calving (August through September) and Post-Hunting (December through January) Periods, 1975 through 2000

In 2000, elk were monitored as part of a special study of movement and the population dynamics of the Rattlesnake Hills elk herd (PNNL-13331). This work was intended to monitor the population characteristics of the herd and continue to provide the scientific information to detect any impact Hanford Site operations may have on the elk population. The information also contributes to the currently evolving Rattlesnake Hills elk herd management issues and documents the success of herd reduction efforts.

The frequency of elk crossing State Highway 240 and the occupancy of central Hanford by elk increased after the June 2000 fire.[b] There were four elk/vehicle collisions in calendar year 2000 as a result of the increased highway crossings. The collision sites generally corresponded to the location of a bull elk/vehicle collision on April 7, 1998 and another February 6, 1999 (Figure 8.2.4). All of these elk/vehicle collisions occurred between road-mile markers 13 and 19 and correspond to elk movements documented in PNNL-13331.

(a) Brett Tiller, Pacific Northwest National Laboratory, Richland, Washington, 2000, unpublished data.
(b) Ibid.

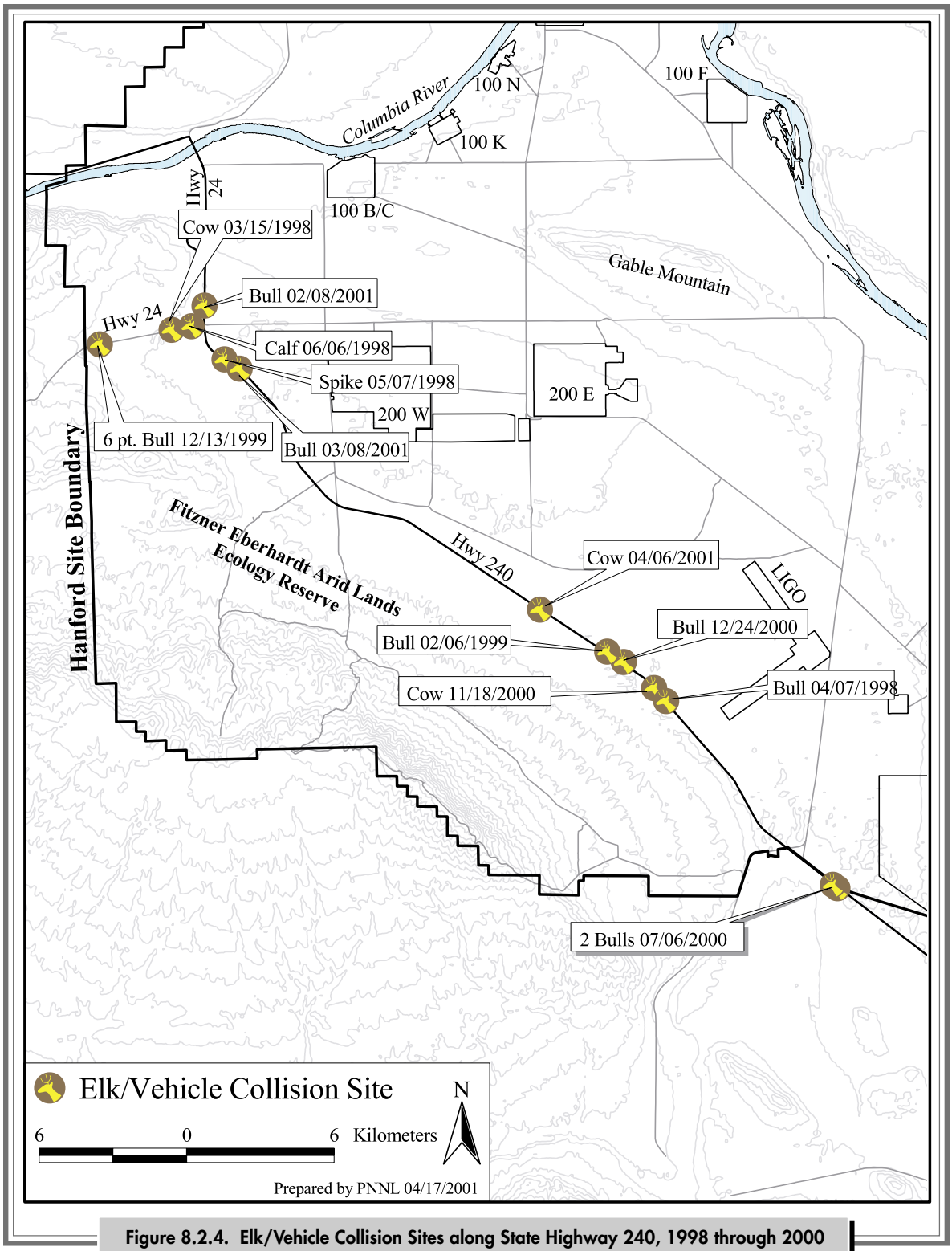

Figure 8.2.4. Elk/Vehicle Collision Sites along State Highway 240, 1998 through 2000

Weekly aerial surveys of 23 radio-collared elk showed that the number of times animals crossed into central Hanford in groups of one or more peaked at 15 during December 2000.[c] This represents the minimum number of times that animals crossed the highway since 1) single elk or entire herds may have crossed without radio-equipped animals present, 2) radio-equipped animals may have crossed State Highway 240 twice within a week and, therefore, did not get counted as crossing at all, and 3) radio-equipped animals may have crossed more than twice within any given week.

During fall and winter 2000-2001, the increasing number of elk crossing State Highway 240 resulted in an increased elk use of central Hanford. By mid-winter, ~80 animals were within the area bounded by State Highway 240 and the Columbia River. The majority of these animals occupied a site near a surface contamination area south of the 200-East Area; however, very few elk tracks or elk observations were within the posted radiation zone.[d] Tissue samples from 1999 and 2000 indicated the animals did not contain elevated levels of radionuclides from Hanford-derived sources (see Section 4.5). Long-term ecological impact plots are located in these areas and future monitoring will provide additional information for managing the elk population in this area.

8.2.5 Mule Deer

Systematic roadside observations have been conducted during the post-hunting (December-January) periods since 1993. The surveys are conducted to monitor trends in age and sex ratios of mule deer, to examine trends in the relative abundance of deer on the Hanford Site, and to monitor the frequency of testicular atrophy in mule deer. The survey route is divided into a north and south region just north of the Old Hanford Townsite.

Epidemiological data and microscopic examinations of mule deer (*Odocoileus hemionus*) residing on the Hanford Site in the early 1990s revealed that nearly one quarter of the mule deer (bucks) had undergone some level of testicular atrophy (degeneration of the testicles after maturity). A special study was initiated in 1992 to describe the occurrences on a spatial scale and to examine possible influences of contaminants from the Hanford Site. The results of this study (Tiller et al. 1997; PNNL-11518) found no single factor as the primary cause, and analyses of affected animal movement patterns revealed no spatial correlations with Hanford Site contamination plumes. In addition, contaminant levels found within the study animals were well below levels that have been shown to cause testicular atrophy in experimental cases. Also, enzyme activation analysis failed to indicate the presence of manmade contaminants in the livers of either normal or affected animals.

Tiller et al. (1997) described a positive relationship between the frequency of the anomaly and the age class distribution within the population. Severely degenerative/atrophic testes were found to occur only in 5- to 12-year-old bucks. Since hunting is not allowed on Hanford Site, deer survival rates are high and there is a corresponding increase in the number of animals in the older (5+ years) age classes, thus magnifying the frequency of this condition in the Hanford Site deer population.

Figure 8.2.5 illustrates trends in the observed frequency of bucks (number of affected males per 100 males) that exhibited signs of testicular atrophy (velvet-covered antlers) and atrophic (shrunken)

(c) Brett Tiller, Pacific Northwest National Laboratory, Richland, Washington, 2000, unpublished data.
(d) Ibid.

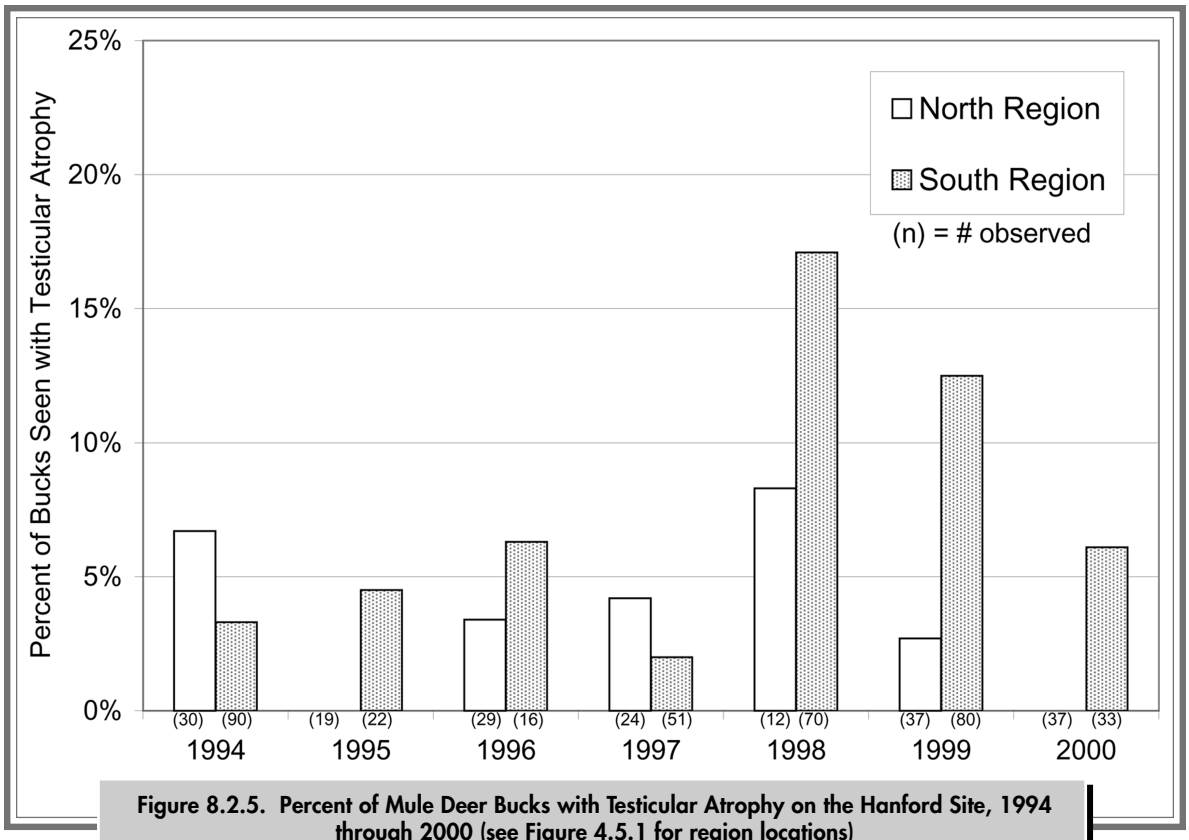

Figure 8.2.5. Percent of Mule Deer Bucks with Testicular Atrophy on the Hanford Site, 1994 through 2000 (see Figure 4.5.1 for region locations)

testicles during the post-hunting roadside surveys from 1994 through 2000. In 1993, an estimated 15% of the males were affected on the Hanford Site (Tiller et al. 1997). Ten affected animals were euthanized in 1994 and 1995 to obtain a variety of tissue samples for chemical and histologic examination. Between 1994 and 1997, the percentage of affected males decreased to around 5% and remained relatively constant; however, survey results in 1998 and 1999, indicated the frequency of the anomaly returned to 1993 levels (15%). Also, more animals in the south region appeared to be affected (see Figure 8.2.5). Survey results obtained in 2000 indicate the frequency of bucks with testicular atrophy is down (~6% [2 of 33] in south region deer herds and 0% [0 of 37] in the north region deer herds).

The changes in proportion affected may be related to changes in the proportion of older age class males (greater than 5 years of age) alive in the resident deer herd. In 1994 and 1995, ten older, affected animals were removed for histological and chemical analyses, while in 2000, many deer in the north region herd were illegally harvested along the Columbia River shoreline. Continued deer monitoring will help determine if age is indeed the only mechanism responsible for the observed change.

The number of fawns surviving the first year after birth is used to document population-level changes in the deer herds. Figure 8.2.6 illustrates trends in fawn:doe ratios from 1994 through 2000 in the north and south region deer herds. In both regions, fawn survival declined substantially from over 20 fawns per 100 does in 1994 to less than 10 fawns per 100 does in 1997. Since 1997, fawn survival has recovered to over 45 fawns per 100 does in 2000, which is similar to other deer populations in the shrub-steppe ecosystem. The observed trends in the rates fawns survive the first year suggest a cyclic

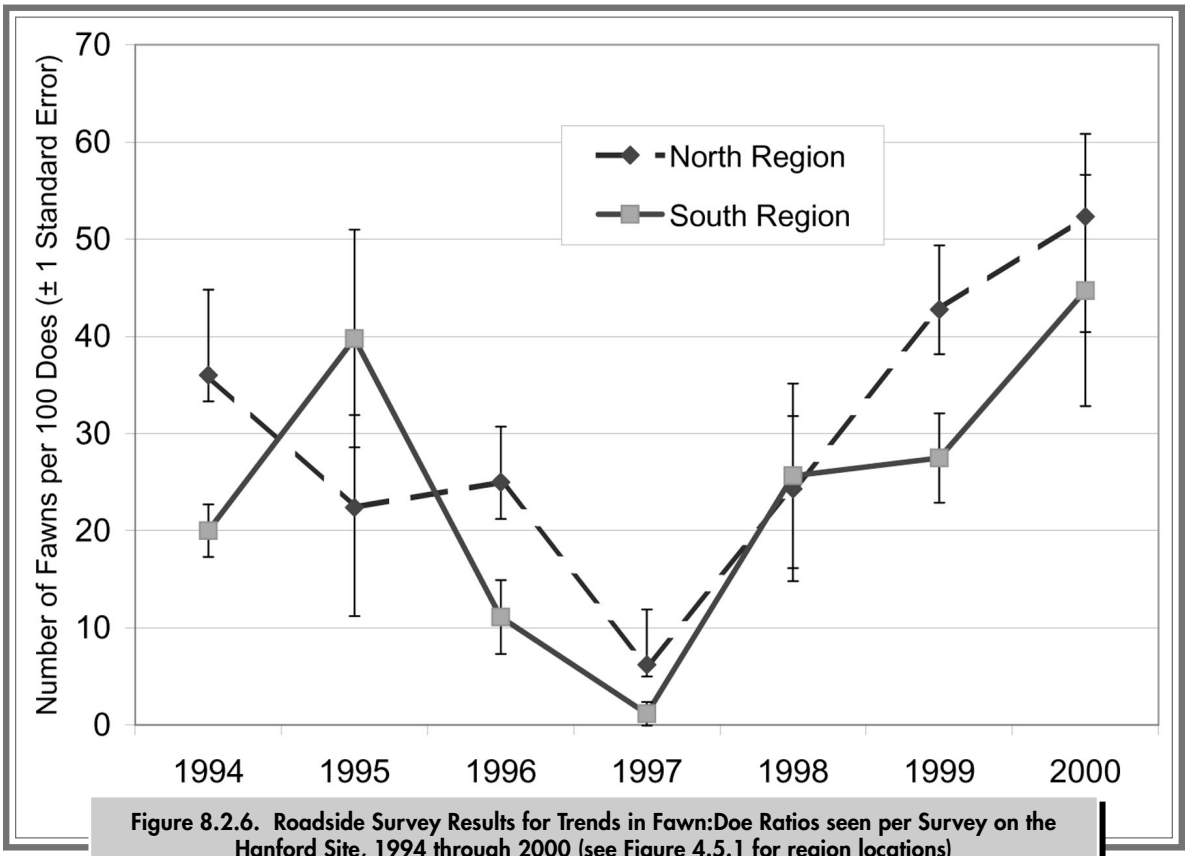

Figure 8.2.6. Roadside Survey Results for Trends in Fawn:Doe Ratios seen per Survey on the Hanford Site, 1994 through 2000 (see Figure 4.5.1 for region locations)

pattern. It is unknown whether the observed cycle is the result of natural processes or man-induced change.

Continued roadside surveys to monitor both the frequency of testicular atrophy and to document the demographic trends of mule deer on the Hanford Site will allow project scientists to evaluate the health of the deer population and attempt to isolate factors contributing to any observed changes.

8.2.6 Plant Biodiversity Inventories

The Hanford Site contains biologically diverse shrub-steppe plant communities that have been protected from disturbance, except for fire, over the past 55 years. This protection has allowed plant species and communities that have been displaced by agriculture and development in other parts of the Columbia Basin to thrive at Hanford. Surveys and mapping efforts have documented the occurrence and extent of rare plant populations and plant community types on the Hanford Site (Nature Conservancy 1999). Populations of rare plants include taxa listed by Washington State as endangered, threatened, or sensitive (see Appendix G) and the locations of species that are listed as review group 1 (i.e., taxa in need of additional field work before status can be determined) (Washington Natural Heritage Program 1997). Data are collected for plant populations and plant communities to develop baseline information and to monitor any changes resulting from Hanford operations. The data provide information that is critical to site planning processes and land-use policy development.

More than 100 rare plant populations of 31 different taxa are found at the Hanford Site (Figure 8.2.7). The U.S. Fish and Wildlife Service has designated five of these 31 taxa (including the two new species, *Eriogonum codium* and *Lesquerella tuplashensis* [Umtanum buckwheat and White Bluffs bladderpod]) as species of concern in the Columbia River Basin Ecoregion. These two new species are proposed as candidates for federal listing. In addition to the rare plant populations, several areas on the Hanford Site are designated as special habitat types with regard to potential occurrence of plant species of concern. These include areas that could support populations of rare annual forbs that have been documented in adjacent habitat.

Surveys in 2000 continued to indicate increases in the numbers of *Erigeron piperianus* (Piper's daisy), a species of concern occurring in the 200 Areas. Populations of another species of concern in the Columbia River Basin Ecoregion, *Rorippa columbiae* (persistent sepal yellowcress), do not appear to have experienced significant recovery after declining as a result of the high river flow levels over the past 4 years. *Rorippa columbiae* is a rhizomatous perennial found in moist soils along the Columbia River within the Hanford Site. This species is often inundated by river flows, but little is known concerning long-term survival under continuous inundation. Surveys in 2000 continued to show low numbers of stems at a cobble beach adjacent to the 100-F Area on the Hanford Reach and on Island 18 across from the 300 Area (Table 8.2.1), and no stems were observed in flower between 1997 and 1999. Number of stems found in 2000 on Locke Island did increase from previous years with ~4% of the plants exhibiting flowers.

Maps showing the extent and distribution of types of vegetation cover found on the Hanford Site have been updated to include recent work delineating the plant communities in central Hanford (Salstrom and Easterly 1997; Nature Conservancy 1999). The updated maps were merged with existing maps for the Fitzner/Eberhardt Arid Lands Ecology Reserve Unit, the Wahluke Wildlife Unit, and the Saddle Mountain Unit of the Hanford Reach National Monument. The plant community map will be updated in 2001 to reflect the changes in plant community composition resulting from the wildfire in June 2000 (see Section 5.0). These maps are documented in the draft of the Hanford Site Biological Resource Management Plan (DOE/RL-96-32) and can be viewed on the Ecosystem Monitoring Project web page (www.pnl.gov/ecology/ecosystem).

8.2.7 Sagebrush Die-Off

Big sagebrush (*Artemisia tridentata* subspecies *wyomingensis*) is the most common shrub component of shrub-steppe vegetation on the Hanford Site. Sagebrush stands represent an important resource for wildlife that are dependent on sagebrush habitat to survive and successfully reproduce, such as black-tailed jackrabbits, sage sparrows, sage grouse, and loggerhead shrikes. Since 1993, areas of sagebrush die-off have been documented in stands near the 100-D Area, the cause of which is not known. Shrub die-off is not uncommon in the intermountain west and such episodes have been reported from British Columbia, Idaho, Nevada, Utah, and Wyoming (Dobrowolski and Ewing 1990). Die-off of shrubs has been attributed to severe rootlet mortality, root rot, soil salinity and anaerobiosis, and vascular shoot wilt induced by fungal pathogens (Nelson et al. 1989; Weber et al. 1989). To date, no evidence exists suggesting any relationship between Hanford Site operations and the distribution and extent of the die-off of sagebrush. Big sagebrush is the only vascular plant species that has declined in the areas monitored. Other shrubs, such as hopsage (*Grayia spinosa*) and bitterbrush (*Purshia tridentata*), with similar deep root systems appear unaffected. In the monitored areas, herbaceous plant

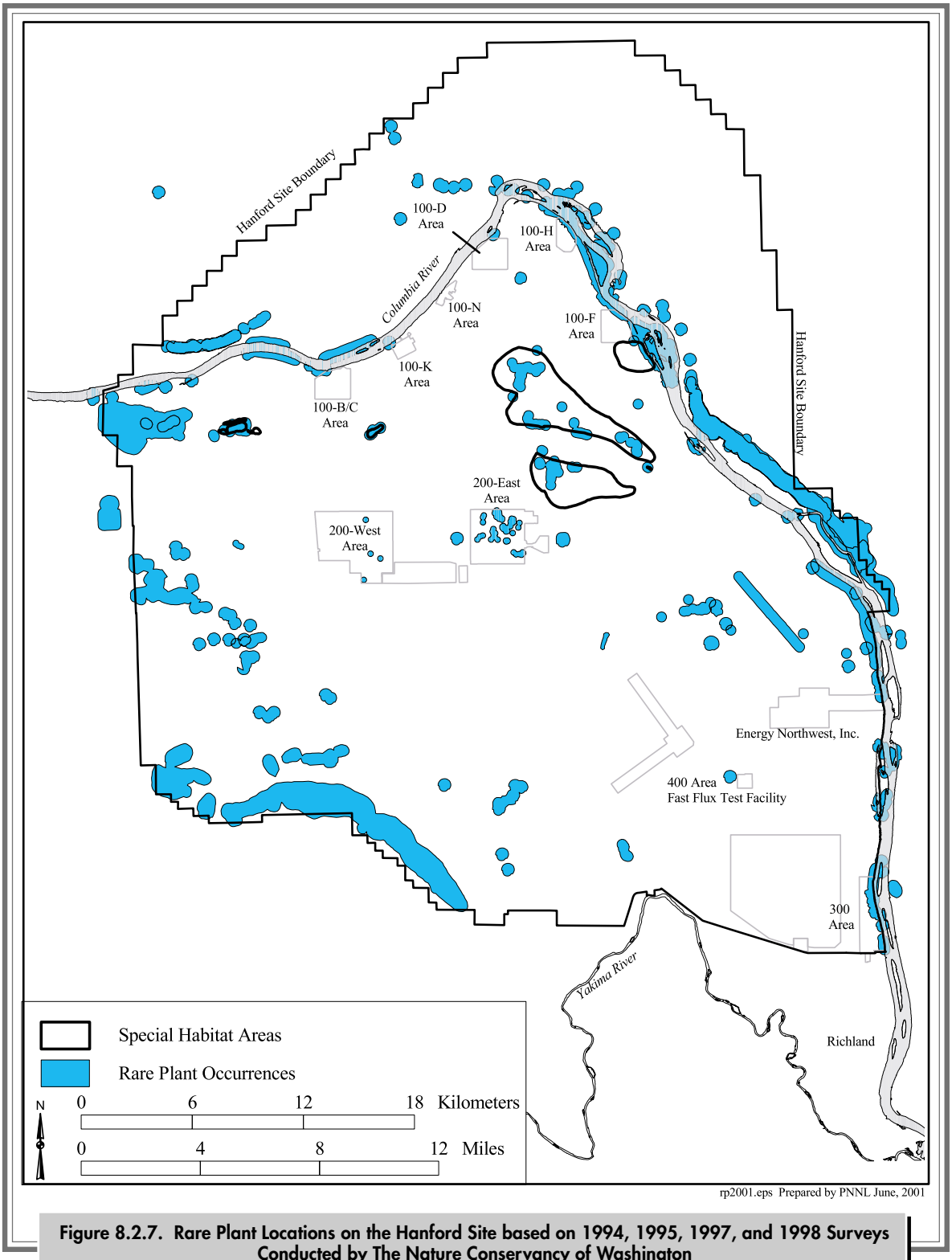

Figure 8.2.7. Rare Plant Locations on the Hanford Site based on 1994, 1995, 1997, and 1998 Surveys Conducted by The Nature Conservancy of Washington

Table 8.2.1. Numbers of *Rorippa columbiae*[a] Stems Counted along the Hanford Reach of the Columbia River, 1994, 1998, 1999, and 2000

Survey Location	1994 Counts	1998 Counts	1999 Counts	2000 Counts
100-F beach	>15,000	70	94	196
Locke Island	>10,000	117	Not surveyed[b]	1,038
Island 18[c]	>10,000	0	Not surveyed	19

(a) Persistent sepal yellowcress.
(b) High water levels prevented access to populations.
(c) Located in the Columbia River at the 300 Area.

species, such as native bunchgrasses, also appear to remain relatively healthy and vigorous.

The extent of the die-off on the Hanford Site was mapped and survey data were collected in 1996 and 1997 to establish a baseline for monitoring future expansion of the die-off (PNNL-11700). The resulting report indicated that a total area of 1,776 hectares (4,388 acres) showed evidence of sagebrush decline, with a central portion of 280 hectares (692 acres) where shrub death was estimated to be ~80% or greater. Observations of shrub vigor (percent canopy defoliation) show continuing declines in shrub health in the die-off areas and along the boundary of the die-off areas.

Annual surveys from 1997 through 1999 of shrubs within the die-off areas indicate that sagebrush plants continue to decline. Shrubs along transects were classified by amount of live canopy in the following manner: dead, less than 50% live canopy, 50 to 90% live canopy, and more than 90% live canopy. These measurements indicated that though few shrubs actually died along each measured transect, 10% to 35% of shrubs measured declined by at least one category between 1997 and 2000. Surveys in 2000 indicate no further decline of the sagebrush (Table 8.2.2). However, the data also indicate a lack of establishment of new shrub seedlings that would be necessary for recovery of the population.

Table 8.2.2. Decline of Sagebrush Conditions Measured along Six Transects within and along the Boundaries of the Sagebrush Die-Off Area on the Hanford Site

Transect	% Dead 1997	% Dead 1999	% Dead 2000	% >90% Live Canopy 1997	% >90% Live Canopy 1999	% >90% Live Canopy 2000
1 (n=27)	95	95	95	5	5	5
2 (n=34)	18	18	18	41	35	22
3 (n=31)	81	84	84	10	0	0
4 (n=50)	48	48	48	14	4	6
5 (n=61)	15	16	20	43	15	24
6 (n=51)	18	18	18	54	27	27

n = Number of shrubs.

8.2.8. Ecological Compliance

DOE Richland Operations Office policies require that all projects having the potential to adversely affect biological resources have an ecological compliance review performed prior to initiation of the project. This review ensures that the DOE is in compliance with the *Endangered Species Act* and the *Migratory Bird Treaty Act*. It also ensures that other significant resources such as Washington State listed species of concern, wetlands, and native shrub steppe habitats are adequately considered during the project planning process. Where effects are identified, mitigation action is prescribed. Mitigation actions can include avoidance, minimization, rectification, or compensation.

Since many projects occur during periods of the year when the plants are not growing and plants are difficult to identify or evaluate, each of the operational areas (200-East and 200-West, all of the 100 Areas, and the 300 Area) are surveyed each spring. These baseline surveys provide information about the habitat types, and species inventories and abundance, which can then be used throughout the rest of the year to assess potential project impacts. Examples of the baseline survey maps are available at http://www.pnl.gov/ecology/ecosystem/Compliance/comp.html.

A total of 98 ecological compliance reviews were performed during 2000 in support of general Hanford Site activities. An additional 63 reviews were performed in support of environmental restoration activities. The total number of reviews prepared in 2000 (161) was slightly less than in previous years (Table 8.2.3).

Table 8.2.3. Ecological Reviews Performed by Pacific Northwest National Laboratory, 1997 through 2000

Calendar Year	100 Areas	200 Areas	300 Area	Other[a]	Total
1997	8	79	44	33	164
1998	42	91	28	47	208
1999	36	72	36	52	196
2000	36	52	27	47	161
Totals	121	294	135	179	729

(a) Includes the 400, 600, 700, Richland North, and former 1100 Areas.